

-28-

WHAT IS CLAIMED IS:

- 1 1. An exhaust-aftertreatment-apparatus diagnosis system
2 for an internal combustion engine, comprising:
 - 3 an exhaust ambience varying section varying a ratio
4 between an oxidizing agent and a reducing agent in
5 exhaust gas of the engine;
 - 6 an exhaust aftertreatment apparatus disposed in an
7 exhaust passage of the engine, the exhaust aftertreatment
8 apparatus selectively executing an adsorbing operation
9 and a reducing operation of the exhaust gas according to
10 the ratio;
 - 11 a first exhaust ambience detector disposed upstream
12 of the exhaust aftertreatment apparatus, the first
13 exhaust ambience detector detecting a first ratio between
14 the oxidizing agent and the reducing agent of the exhaust
15 gas upstream of the exhaust aftertreatment apparatus;
 - 16 a second exhaust ambience detector disposed
17 downstream of the exhaust aftertreatment apparatus, the
18 second exhaust ambience detector detecting a second ratio
19 of the oxidizing agent and the reducing agent of the
20 exhaust gas downstream of the exhaust aftertreatment
21 apparatus;
 - 22 a first deterioration diagnosing section diagnosing
23 a deterioration of the exhaust aftertreatment apparatus
24 on the basis of the first and second ratios obtained
25 under a first engine operating condition under that the
26 exhaust ambience is changed; and
 - 27 a second deterioration diagnosing section diagnosing
28 the deterioration of the exhaust aftertreatment apparatus
29 on the basis of the first and second ratios obtained
30 under a second engine operating condition when the first

-29-

31 deterioration diagnosing section diagnoses that the
32 exhaust aftertreatment apparatus is deteriorated.

1 2. The diagnosis system as claimed in claim 1, wherein
2 the first deterioration diagnosing section diagnoses the
3 deterioration of the exhaust aftertreatment apparatus
4 when the engine operating condition is changed from a
5 lean burn operation to a rich burn operation or from the
6 rich burn operation to the lean burn operation.

1 3. The diagnosis system as claimed in claim 2, wherein
2 the first deterioration diagnosing section comprising an
3 integral section for calculating an integral quantity of
4 a difference between an output of the first exhaust
5 ambience detector and an output of the second exhaust
6 ambience detector from a first moment that the output of
7 the first exhaust ambience detector is varied to a
8 predetermined value to a second moment that the output of
9 the second exhaust ambience detector is varied to the
10 predetermined value, and the first deterioration
11 diagnosing section diagnoses the deterioration of the
12 exhaust aftertreatment apparatus on the basis of the
13 integral quantity.

1 4. The diagnosis system as claimed in claim 1, wherein
2 the second deterioration diagnosing section diagnoses the
3 deterioration of the exhaust aftertreatment apparatus by
4 transiting the engine operating condition to a
5 stoichiometric air/fuel ratio operating condition.

1 5. The diagnosis system as claimed in claim 4, wherein
2 the second deterioration diagnosing section comprises an

-30-

3 exhaust air/fuel ratio feedback controlling section for
4 feedback controlling the exhaust air/fuel ratio at ratios
5 near the stoichiometric air/fuel ratio on the basis of
6 the output of the second exhaust ambience detector and a
7 cycle measuring section for measuring a cycle of a
8 feedback quantity during when a feedback control being
9 executed by the exhaust air/fuel ratio feedback
10 controlling section, and the second deterioration
11 diagnosing section diagnoses the deterioration of the
12 exhaust aftertreatment apparatus on the basis of the
13 cycle.

1 6. The diagnosis system as claimed in claim 1, wherein
2 the exhaust aftertreatment apparatus includes attached to
3 a compression ignition engine.

1 7. The diagnosis system as claimed in claim 1, wherein
2 the first engine operating condition, under which the
3 first deterioration diagnosing section diagnoses the
4 deterioration of the exhaust aftertreatment apparatus,
5 includes a rich spike control condition wherein the
6 engine operating condition is temporally varied from a
7 lean burn condition to a rich burn condition.

1 8. The diagnosis system as claimed in claim 1, wherein
2 the second engine operating condition, under which the
3 second deterioration diagnosing section diagnoses the
4 deterioration of the exhaust aftertreatment apparatus,
5 includes a stoichiometric air/fuel ratio control.

1 9. The diagnosis system as claimed in claim 1, wherein
2 the exhaust aftertreatment apparatus selectively executes

-31-

3 an adsorbing operation of nitrogen oxide in the exhaust
4 gas and a reducing operation of the nitrogen oxide.

1 10. The diagnosis system as claimed in claim 1, wherein
2 the first deterioration diagnosing section diagnoses the
3 deterioration of the exhaust aftertreatment apparatus on
4 the basis of the first and second ratios obtained after
5 an operation for temporally varying the engine operating
6 condition from a lean burn condition to a rich burn
7 condition.

1 11. The diagnosis system as claimed in claim 1, wherein
2 the exhaust aftertreatment apparatus comprises a NOx trap
3 catalyst.

1 12. The diagnosis system as claimed in claim 11, wherein
2 the exhaust aftertreatment apparatus further comprises a
3 diesel particulate trap disposed downstream of the NOx
4 trap catalyst.

1 13. The diagnosis system as claimed in claim 12, wherein
2 the exhaust aftertreatment apparatus further comprises an
3 oxidizing catalyst disposed upstream of the NOx trap
4 catalyst.

1 14. The diagnosis system as claimed in claim 1, wherein
2 the first deterioration diagnosing section diagnoses the
3 deterioration of the exhaust aftertreatment apparatus on
4 the basis of a change of a catalyst downstream side
5 air/fuel ratio relative to a change of a catalyst
6 upstream side air/fuel ratio during a rich spike control,
7 and the second deterioration diagnosing section diagnoses

-32-

8 the deterioration of the exhaust aftertreatment apparatus
9 from an inversion cycle of a feedback quantity during the
10 feedback control of the catalyst downstream side air/fuel
11 ratio during a stoichiometric control when the first
12 deterioration diagnosis made a deterioration
13 determination.

1 15. A method of diagnosing an exhaust aftertreatment
2 apparatus for an internal combustion engine, the exhaust
3 aftertreatment apparatus being disposed in an exhaust
4 passage of the engine and purifying exhaust gas of the
5 engine according to a ratio between an oxidizing agent
6 and a reducing agent in the exhaust gas, which is varied
7 by an exhaust ambience varying section, the method
8 comprising:
9 detecting a first ratio between the oxidizing agent
10 and the reducing agent of the exhaust gas upstream of the
11 exhaust aftertreatment apparatus;
12 detecting a second ratio of the oxidizing agent and
13 the reducing agent of the exhaust gas downstream of the
14 exhaust aftertreatment apparatus;
15 executing a first diagnosis for diagnosing a
16 deterioration of the exhaust aftertreatment apparatus on
17 the basis of the first and second ratios obtained under a
18 first engine operating condition under that the exhaust
19 ambience is changed; and
20 executing a second diagnosis for diagnosing the
21 deterioration of the exhaust aftertreatment apparatus on
22 the basis of the first and second ratios obtained under a
23 second engine operating condition when the first
24 deterioration diagnosing section diagnoses that the
25 exhaust aftertreatment apparatus is deteriorated.

-33-

1 16. An exhaust-aftertreatment-apparatus diagnosis system
2 for an internal combustion engine, comprising:

3 exhaust ambience varying means for varying a ratio
4 between an oxidizing agent and a reducing agent in
5 exhaust gas of the engine;

6 exhaust aftertreatment means purifying the exhaust
7 gas by selectively executing an adsorbing operation and a
8 reducing operation of the exhaust gas according to the
9 ratio varied by the exhaust ambience varying means, the
10 exhaust aftertreatment means being disposed in an exhaust
11 passage of the engine;

12 first exhaust ambience detecting means for detecting
13 a first ratio between the oxidizing agent and the
14 reducing agent of the exhaust gas upstream of the exhaust
15 aftertreatment apparatus, the first exhaust ambience
16 detecting means being disposed upstream of the exhaust
17 aftertreatment apparatus;

18 second exhaust ambience detecting means for
19 detecting a second ratio of the oxidizing agent and the
20 reducing agent of the exhaust gas downstream of the
21 exhaust aftertreatment apparatus, the second exhaust
22 ambience detecting means being disposed downstream of the
23 exhaust aftertreatment apparatus;

24 first deterioration diagnosing means for diagnosing
25 a deterioration of the exhaust aftertreatment apparatus
26 on the basis of the first and second ratios obtained
27 under a first engine operating condition under that the
28 exhaust ambience is changed; and

29 second deterioration diagnosing means for diagnosing
30 the deterioration of the exhaust aftertreatment apparatus
31 on the basis of the first and second ratios under a

-34-

32 second engine operating condition when the first
33 deterioration diagnosing means diagnoses that the exhaust
34 aftertreatment apparatus is deteriorated.